DY 11: Superfluidity and Bose-Einstein condensation

Time: Tuesday 9:30–11:00 Location: H2

Invited Talk DY 11.1 Tue 9:30 H2

A single Josephson junction for atomic Bose-Einstein condensates: Dynamics and finite temperature effects — •Markus Oberthaler — Kirchhoff Institut für Physik, University of Heidelberg, Im Neuneheimer Feld 227, 69120 Heidelberg

The recent realization of a single weak link for an atomic Bose-Einstein condensate in an optical double-well potential allows for the first time the observation of Josephson oscillations directly on the level of populations on either side of the junction. Furthermore it opens up the way to fully characterize the tunneling dynamics since not only the dynamics of the population difference can be measured but even the time evolution of the relative phase is detectable. How the residual interaction of the atoms can lead to a new dynamical regime, which is characterized by an inhibition of tunneling, will be discussed in detail.

The good experimental control of the atomic system also allows for a quantitative study of thermally induced fluctuations of the relative phase between the weakly linked condensates. These fluctuations even persist in the ultra low temperature limit and thus can be employed for the realization of a new type of thermometer for atomic Bose-Einstein condensates. Our recent results on the measurement of the heat capacity of a quantum gas at ultra low temperatures using this new noise-thermometer will be presented.

DY 11.2 Tue 10:00 H2

Transport of Bose-Einstein condensates beyond the Gross-Pitaevskii approach — •Thomas Ernst[1], Michael Hartung[1], Tobias Paul[2], and Peter Schlagheck[1] — [1]Institut für Theoretische Physik, Universität Regensburg — [2]Laboratoire de Physique Théorique et Modèles Statistiques, Université Paris Sud, Orsay

We study the transport of Bose-Einstein condensates through scattering potentials in quasi one-dimensional waveguides. While previous works used the Gross-Pitaevskii equation to calculate this process, we employ an approach which goes beyond this mean field theory and which is able to take into account excitations of the condensate as well as its depletion rate. This approach is based on a cumulant expansion [1], where we use a truncation scheme that is formally valid for weak interactions and a large number of atoms. We apply it to the scattering problem of a propagating BEC on a double barrier potential, where resonant transmission of the condensate takes place via the population of dynamically unstable scattering states. Our results confirm the validity of previous calculations of these processes based on the Gross-Pitaevskii equation [2].

[1] T. Köhler and K. Burnett, Phys. Rev. A **65**, 033601 (2002)
[2] T. Paul, K. Richter and P. Schlagheck, Phys. Rev. Lett. **94**, 020404 (2005)

DY 11.3 Tue 10:15 H2

Complex Dynamics in Systems of Interacting Bosons — •Moritz Hiller[1,2], Joshua Bodyfelt[3], Tsampikos Kottos[1,3], and Theo Geisel[1,2] — [1]Max-Planck-Institut für Dynamik und Selbstorganisation, D-37073 Göttingen — [2]Fakultät für Physik, Universität Göttingen, D-37077 Göttingen — [3]Department of Physics, Wesleyan University, CT-06459 Middletown, USA

We consider interacting bosons described by a Bose-Hubbard Hamiltonian (BHH) and analyze the evolving energy distribution as an experimentally controllable parameter, the coupling strength k between neighboring sites, is changed. Three driving schemes of k are considered: (a) the sudden limit (LDoS analysis), (b) the one-pulse scheme (wavepacket dynamics), and (c) the time-reversal scheme (fidelity). We find in all cases two distinct regimes: the Linear Response regime where we can trust the Fermi-Golden-Rule picture, and what we call the non-perturbative regime where the perturbation k is quantum mechanically large. In the former regime, the evolving distribution can be described by an improved Random Matrix Theory (RMT) which takes into accont the structured energy landscape of the perturbation operator. Instead, in the latter regime, non-universal features of the underlying classical dynamics dictate the energy spreading thus leading to a clash with the predictions of RMT. Our results are relevant to a vast number of experimental realizations of the BHH, like condensate systems in optical lattices and intra-molecular energy flow of vibrational degrees of freedom.

DY 11.4 Tue 10:30 H2

Phase diagram for interacting Bose systems — •Michael Maennel[1], Klaus Morawetz[1,2], and Michael Schreiber[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany

We propose a new form of the inversion method in terms of selfenergy expansion to access the phase diagram of the Bose-Einstein transition. The dependence of the critical temperature on the interaction parameter is calculated. This is discussed with the help of a new condition for Bose-Einstein condensation in interacting systems which follows from the pole of the T-matrix the same way as from the divergence of the medium-dependent scattering length. A conserving many-body approximation consisting of screened ladder diagrams is proposed which describes the MC data more appropriate. The specific results are that a non-selfconsistent T-matrix leads to a linear coefficient in leading order of 4.7, the selfconsistent T-matrix due to the effective mass to a coefficient of 1.3 and the screened ladder approximation to 2.3 close to the Monte Carlo data.

DY 11.5 Tue 10:45 H2

Density Distribution for Ideal Trapped Bose Gases — •Walja Korolevski[1], Konstantin Glaum[1], and Axel Pelster[2] — [1]Institut für Theoretische Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Fachbereich Physik, Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany

Within the path integral formulation of density matrices, a recursion relation for the density distribution of N ideal harmonically confined bosons is derived. The respective canonical results are compared with calculations within the grand-canonical ensemble. Thereby, we show near the transition temperature that the densities of the ground state and the excited states have the same order of magnitude. Whereas the standard semiclassical approximation of the grand-canonical calculation yields appropriate results only in the thermodynamic limit, its correactions lead to finite-size effects which contain divergent terms. Therefore, we follow Ref. [1] and work out a modified semiclassical approximation which leads to reasonable finite-size corrections not only for the density distribution but also for the critical temperature and the specific heat.

[1] V.I. Yukalov, Phys. Rev. A **72**, 033608 (2005)